From Pete Tuttle

Greg - FYI
Jose - Keep

Dear Judy,

I appreciate the inquiry on this matter and I hope that I am able to provide some useful information. Because of certain complicating factors (Arizona is not in my area of official concern), I have treated your request for information somewhat informally. I apologize. Official comments from the Service should come from the Arizona State Office. I might suggest contacting Kirke King, the Fish and Wildlife Service Environmental Contaminant Specialist for Arizona, at (602) 379-4720. Kirke should be able to provide additional insight into this matter in the early stages of project development. He could certainly offer more site specific information.

In regard to the matter of the Migratory Bird Treaty Act (MBTA), the company is correct in that the MBTA does not require migratory bird access restriction to toxic ponds or other measures to avoid accidental take. The MBTA simply makes it unlawful to kill migratory birds without a license or permit. However, no permits are issued for take of migratory birds with toxic ponds. The MBTA is a strict liability provision, meaning that intent or knowledge of taking is not required for a conviction. Penalties for a misdemeanor conviction of the MBTA may include fines up to $5,000 per individual and $10,000 per organization. The MBTA also provides for 6 months imprisonment for a misdemeanor conviction. However, I am not aware that imprisonment has been pursued in any mine-related MBTA violation. Similarly, I am not aware that a felony conviction has ever been pursued in a case involving migratory bird take at a mine. In Nevada, it has been interpreted that each bird constitutes one count ($10,000 per dead bird). The maximum fine levied to a mine in Nevada for migratory bird mortality was $500,000. Therefore, there is incentive to comply with the law.

The State of Nevada does have a law requiring companies to restrict wildlife access artificial bodies of water containing chemicals directly associated with the processing of ore in quantities that cause wildlife mortality. However, broad language in the bill allows much "wiggle room", and the law has been ineffective in cases of acid leaching and acidic ponds. I'm not sure if Arizona has any similar laws, but it's worth looking into.

The position that cyanide ponds, but not sulfate solution ponds, are attractive to birds has little merit. In Nevada, we found that the greatest incidence of cyanide-related migratory bird mortality typically occurred during periods of migration. Apparently, any body of water, be it a lined solution pond or a puddle in a playa, may be attractive to tired waterfowl and shorebirds migrating through arid areas. In this respects, a sulfate solution pond may be no more or no less attractive to a bird than a cyanide pond. The length of time that a bird remains at a pond depends on a number of factors, such as the availability of food or the palatability of the water (or in the case of some of the more toxic cyanide ponds, until removed by a law enforcement official). If no food or suitable water is present, migrating birds may not remain at the site for extended periods. Birds may also frequent a certain body of water because it offers some other value, such as suitable habitat for certain activities. As an example, resident geese in one area in Nevada use a mine pit lake for resting during hours of darkness. The pit lake supports no food base and the water quality is quite poor, but the lake presumably is attractive for some other reason (protection from predators?). Similarly, the saline ponds may be the only body of water not frozen during periods of extreme cold, in which case the ponds would be very attractive to certain bird.

I am not aware of any information suggesting that sprayers (sprinklers?) will deter birds from using the evaporation ponds. On the contrary, bird mortality seems to be higher on heaps using sprinklers, as opposed to drip lines, to disperse cyanide solutions. I would be interested in any data or information the project proponent may have on this subject. Along these lines, mines in Nevada have found few measures that are effective in reducing bird use on cyanide ponds. Physical exclusion and cyanide neutralization have proven to be the most effective for reducing migratory bird mortality. Hazing, which has included methods such as propane cannons, "cracker" shells fired from shotguns, plastic owls and alligators, and remote controlled boats and airplanes, has proven to be very ineffective.

There are a number of potential problems that I see with the facility that you have described. First, the pH of the raffinate or pregnant ponds has the potential to adversely affect wildlife. Effect would depend on certain factors, such as acid concentration and exposure. However, a pH ranging from 1.7 to 2.2 certain has the potential to cause adverse effects (I believe that DOT classifies liquids with a pH of 2.0 or less as hazardous materials). Effects may range from minor irritation to chemical burns. Because of irritation, it is likely that a bird landing on the pond would leave before mortality resulted. However, chemical burns are susceptible to infection and delayed mortality of birds landing on acidic ponds, even for brief time periods, could be a real possibility. Unfortunately, I have no data to back this point. Similarly, I have no information of the effects of acid on feathers, but damage to feathers or oils could affect survival. Unfortunately, a case that involves delayed mortality would probably not result in a dead bird "in hand." Therefore, a violation of the MBTA may be extremely difficult to prove.

The salinity of the evaporation ponds could also be a problem. Service personnel in New Mexico have documented considerable mortality of birds, primarily waterfowl, using hypersaline playa lakes. Total dissolved solids concentrations of these lakes range up to around 300,000 ppm. The greatest incidence of mortality seems to occur during periods of cold weather when other surface waters in the area are frozen. Because of high salinity, the hypersaline playa lakes remain unfrozen and are "attractive" to waterfowl. Under these conditions, mortality may be substantial (hundreds per day). Effects to waterfowl seem to arise from salt becoming encrusted on feathers. As a result, birds may lose its ability to fly and/or the water repellant properties of the feathers may be reduced. In controlled studies, sodium poisoning was determined to be the eventual cause of death. Ingestion of sodium may result from drinking limited amounts of water and preening. Under natural conditions, predation (resulting from the inability to fly) and hypothermia (resulting from loss of the water repellant properties of the feathers) may be responsible for many of the deaths. For more information on this issue, I suggest contacting Mark Wilson, the Service Environmental Contaminant Specialist at the New Mexico State Office, at (505)761-4525.

The issue of adverse effects to migratory birds from metals or other trace elements in the ponds is difficult to address. Several constituents in the ponds can certainly cause mortality or significant sublethal effects to wildlife, and levels predicted in the ponds are capable of resulting in toxic exposure under the right conditions. However, exposure in the case you have described is uncertain. Exposure would require ingestion. In view of the salinity of the water, ingestion of water in quantities likely to produce adverse effects from trace elements is unlikely. In the case of the hypersaline playa lakes mentioned above, sodium poisoning caused death of waterfowl before metals or other trace elements produced an adverse effect. Therefore, diet may be the primary exposure pathway of concern. However, exposure through diet would require the establishment of some biological community in or around the ponds.

The possibility that a biological community will develop in these ponds is not unreasonable. Several invertebrates common in the southwest are tolerant of high salinity and probably capable of surviving or even thriving in the evaporations ponds. In extreme examples, brine flies (*Ephydra* spp.) and brine shrimp (*Artemia* spp.) can tolerate salinities ranging up to the saturation point of sodium chloride (Wirth 1971; Pennack 1989). In fact, Pennack (1989) reports that *Artemia* occur in evaporation ponds of commercial salt production facilities. Agricultural drain water evaporation ponds in the San Joaquin Valley of California provide examples of the ability of certain aquatic plants and invertebrate to thrive under conditions of high dissolved solids (total dissolved solids in drain water evaporation ponds may range from <3,000 to over 388,000 ppm; Moore et al. 1990). Some of these ponds are extremely productive and are heavily used by certain birds, particularly shorebirds (Skorupa and Ohlendorf 1991). Many (most?) trace elements have a high affinity to bioaccumulate in lower organisms, and plants and invertebrates in the drain water evaporation ponds may accumulate hazardous levels of certain trace elements. Birds feeding in the evaporation ponds are exposed to these trace elements through diet. Trace elements, primarily selenium, are believed to be responsible for the extremely high incidence of teratogenesis (embryonic deformity) in migratory bird nesting near some of these ponds.

As per your request, I have provided information on trace element toxicity to avian species. Most of the referenced studies have examined trace elements in diet. I am not aware of many studies that have examined exposure through water. I have omitted discussions on toxicity to aquatic life. However, the "100-year flood level" designation on the map leads me to believe that the facility is at risk of flooding. A release of water of this quality to surface waters could prove extremely damaging to aquatic life. Because of trace element persistence, an accidental release could continue to impact aquatic communities for extended periods. If you require information on toxicity to aquatic life, please contact me.

<u>Aluminum</u>

Aluminum appears to accumulate in potential avian dietary items (plants and invertebrates) but does not concentrate in food chains. Aluminum toxicosis in birds is attributed to the formation of insoluble phosphates in the gastrointestinal tract and the interference of phosphate metabolism (Sparling 1990, Miles et al. 1993). Sparling (1990) found that growth and survival of mallard and black ducks (*Anas rubripes*) were affected by dietary aluminum, calcium, and phosphorus. A dietary level of 10,000 µg/g aluminum caused mortality at normal dietary levels of calcium and phosphorus. Growth was reduced and behavior was affected at 5,000 µg/g. Nyholm (1981) suggested that elevated dietary aluminum was associated with avian eggshell malformation. However, Miles et al. (1993) counter this finding.

<u>Arsenic</u>

Like aluminum, arsenic appears to bioaccumulate in certain plants and invertebrates organisms but does not concentrate in food chains (at least inorganic forms that will likely be present in the ponds). Mortality (LC_{50}) of mallards occurred at dietary arsenic concentrations of 1,000 µg/g after 6 days and 500 µg/g after 32 days (National Academy of Sciences 1977). Growth, development, and physiology of mallard ducklings maintained on a diet containing 30 µg/g arsenic or greater were affected (Camardese et al. 1990).

Chromium

Chromium will bioaccumulate in plants and invertebrates. Haseltine et al. (1985) found increased mortality of female black ducks and hatchlings maintained on diets containing 50 µg/g chromium +3. Growth patterns were altered in treated groups, but weights in all groups were similar at 10-weeks of age. Fecundity, egg survival, and embryo development were not affected. Sublethal effects, including histopathology, were found in black ducks maintained on a diet containing 10 µg/g chromium. This study was never formally published. Therefore, I recommend caution when citing this study.

Lead

Because the reported detection limit (1 mg/L) was very high I have included lead (and other trace elements) for your consideration. Lead will bioaccumulate and levels substantially lower than this detection limit may be of concern. I suggest that you get more detailed information (lower detection limits for non-detected trace elements) from the company. Finley et al. (1976) did not find mortality or pathology in mallards maintained on a diet containing 25 µg/g lead for 12 weeks, although some biochemical effects were found. Similar results were found in nestling American kestrels (*Falco sparverius*) administered 25 µg/g lead for 10 days (Hoffman et al. 1985). At a level of 125 µg/g, significant sublethal effects, such as reduced growth and abnormal skeletal development were found. Significant mortality (40%) was found at 625 µg/g.

Mercury

Mercury strongly bioaccumulates and magnifies in the food chain. Like lead, the reported detection limits are substantially higher than levels associated with adverse effects. Hienz (1979) found that a dietary level of 0.5 µg/g methylmercury adversely affected reproduction in three generations of mallards. The 70-day LC_{50} for organic mercury administered through diet of ring-necked pheasants (*Phasianus colchicus*) was 12.5 µg/g (Spann et al. 1972).

Selenium

Elevated selenium in diet has been associated with avian embryonic mortality and teratogenesis Again, the reported detection limit in the information that you provided is substantially higher than waterborne concentrations associated with adverse effect to avian species. Selenium will strongly bioaccumulate and magnify in the food chain. Birds acquire selenium primarily through diet. Ohlendorf et al. (1993) determined that selenium concentrations in water as low as 0.0026 mg/L significantly increased the chance of bird egg mortality and embryonic deformity. Similarly, Skorupa and Ohlendorf (1991) found selenium levels in water between 0.001 and 0.003 mg/L were associated with levels in birds eggs that were associated mortality or embryonic deformity. Lemly and Smith (1987) report a dietary concern level for selenium of 3.0 µg/g for birds. Skorupa and Ohlendorf (1991) identified a critical avian dietary threshold of 5.0 µg/g.

Zinc

Zinc will bioaccumulate. Gasaway and Buss (1972) found reduced survival of mallards maintained on diets containing zinc at concentrations exceeding 3,000 µg/g. Sublethal effects (immunosuppression) in domestic chickens have been found at a dietary level of 178 µg/g (Stahl et al. 1989 as cited in Eisler 1993).

Recommendations

The pH of the pregnant and raffinate ponds could cause injury or mortality of migratory birds. These ponds are small, and migratory bird access could be restricted at a reasonable cost. I would strongly encourage the project proponent to do so. Given the pH of these ponds, nets and net support structures could be subject to corrosion, creating continuous maintenance problems. Therefore, I might suggest the use of floating high density polyethylene balls. These 4-inch diameter balls form a self-adjusting, floating cover on the pond surface. Mining companies using this approach on cyanide ponds in Nevada report very good success in eliminating bird use, and subsequently eliminating mortality. The balls are initially slightly more expensive. However, long-term maintenance costs are minimal. If you need information on companies that provide these products give me a call.

Adverse effects to birds and other wildlife from salt encrustation is also a potential problem. Unfortunately, the size and nature of the ponds (designed to maximize evaporation) might prohibit migratory bird access exclusion at a reasonable cost. Bird and other wildlife occurrence at the evaporation ponds should be closely monitored, particularly during periods of cold weather. In view of limited federal budgets, I might recommend contacting a local group (the State fish and game agency?) to monitor the ponds. Unfortunately, I have no recommendations to rectify the problem if one does occur. Mark Wilson or Kirke King (phone numbers given above) may have some ideas.

Trace element toxicity to birds might be a problem if a food base becomes established in or near the evaporation ponds. The evaporation ponds should be monitored for colonization of aquatic organisms and use by shorebirds. If aquatic organisms become established in ponds, some form of control of these organisms might be needed. Controlling bird use will probably prove ineffective. If control of aquatic organisms or bird use is not attained, I would recommend examining production and incidence of teratogenesis of shore birds nesting in the vicinity. Theoretically, loss of production or teratogenesis of migratory birds may be a violation of the MBTA. However, the US Attorney has, as of yet, refused to take a case involving impacts to migratory birds resulting from evaporation ponds in the San Joaquin Valley, California.

Finally, I have been hearing reports of avian (Canada geese) mortality at the Berkeley Pit in Butte, Montana this past spring. If you are not familiar with the Berkeley Pit, this mine pit lake contains acidic water (pH between 2.7 and 3.2) with elevated levels of a number of trace elements. I have not received reports of a definitive cause of mortality, but I do not believe that the pit lake supports any aquatic organisms. Therefore, mortality may have resulted from direct exposure to water. If mortality was associated with pH, trace elements, or both, this event may has implications to your project. I might suggest contacting some of the EPA folks dealing with this Superfund site.

I hope this information is of some value. I have also sent a copy of this informal letter to Kirke King. If you have questions, or require an official Service letter to reference, please contact me at (702) 784-5227 or Kirke King at (602) 379-4720.

Sincerely,

Peter Tuttle

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